HETEROGENY AND VARIATION IN SOME OF THE COPEPODA OF LONG ISLAND.

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In the spring of 1898, my attention was attracted to certain of the Copepoda that occur in large numbers in the fresh-water ponds in some of the outlying districts of Brooklyn. The material, which contained many *Cyclops*, was collected soon after the ice had disappeared from the surface of these shallow pools and even at this early season most of the *Cyclops* were large and carried eggs in all stages of development.

I isolated individuals with eggs, and subsequently observed numerous color-changes, which accompanied the rapid growth and extrusion of eggs into the egg-sacs. A single instance will suffice to show the rapidity of these changes, and the fertility of the individuals. On the 19th of April, 1898, a *Cyclops*, carrying dark blue eggs, was isolated. On the 20th dark bluish ova could be seen through the transparent body-wall, making the body appear dark, while the dark eggs in the egg-sacs had developed into embryos of a reddish tint. On the 22d the copepod carried dark eggs again, and the body was again almost colorless, with a faint streak on either side, still marking the position of the ovaries. On the 23d it remained unchanged. On the 24th the body was again dark but no eggs were attached. On the 25th the dark eggs were carried in appended sacs and the body was again colorless. On the 26th the dark eggs became detached. On the 27th the body again appeared dark. There is no record in my notes for the next two days, but when I again looked at the copepod the body was colorless. While it carried no egg-sacs, the ova must have been discharged since the last record on the 27th instant.

I attempted to identify the form, which agreed with *C. parcus* (Herrick), in most of the points that are regarded as species-characteristics but it differed from *C. parcus* in the number of its antennal segments.

The chief morphological features by which species of *Cyclops* are recognized are the following :

1. The number of joints in the antennæ.
2. The number of joints in the rami of the four swimming feet.
3. The armature of the swimming feet.
4. The number of joints in the fifth foot, which is rudimentary.
5. The shape and armature of the segments of the fifth foot.
6. The structure of the abdomen with the caudal stylets and the armature of the caudal stylets.
7. The shape of the receptaculum seminis.
8. The armature of the maxillipeds.
9. The relation between the length of the antennæ and the cephalothorax.

The characteristics of *C. parcus* are as follows :

1. Seventeen-jointed antennæ.
2. Three-jointed rami in the swimming feet.
3. Armature of the last segment of the swimming feet.

First Foot.		Second Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus.*
2 outer spines.	1 outer seta.	2 outer spines.	1 outer seta.
2 apical setæ.	1 apical spine.	1 apical spine.	1 apical spine.
	1 apical seta.	1 apical seta.	1 apical seta.
2 inner setæ.	3 inner setæ.	3 inner setæ.	3 inner setæ.

Third Foot.		Fourth Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus.*
Like second.		2 outer spines.	1 outer seta.
		1 apical spine.	
		1 apical seta.	2 apical spines (equal).
		3 inner setæ.	2 inner spines.

4. Two-jointed fifth foot.
5. The basal joint short and broad with a single seta on the outer margin.

A long, cylindrical, distal segment with a blunt, inner spine and a long, outer seta, but very slightly plumose.

6. The abdomen is composed of segments, the first of which is as long as the remaining segments combined. The caudal stylets are long.
7. The receptaculum seminis is broadly oval.
8. There are four hairs on the distal segment of the larger branch of the maxillipeds. The second segment has a large, immovable dactyl with a row of teeth along the edge, and with a

small hair at its base. Attached to the immovable dactyl is a small, movable one.

9. The antennæ are about the length of the cephalothorax.

The points in which the Long Island *Cyclops* that I have studied differs from *C. parcus* are: In the number of antennal segments, there being 13 instead of 17, and in the occasional variation in the armature of the outer ramus of the fourth foot, there being but one outer spine and one seta, where *C. parcus* has typically two spines; as well as in the armature of the terminal joint of the large ramus of the maxilliped, where two small hairs replace one large one; also in the armature of the distal joint of the fifth foot, which carries an outer hair, in place of the unserrated spine which is present in the form with seventeen joints in the antennæ.

As the correlated characteristics of species occur with great regularity in the *Cyclops*, and as the form under consideration seemed, both on account of its relatively large size and its fertility, to be a mature form, I searched for similar individuals but for a long time failed to find them.

In the summer of 1899, I had the opportunity of collecting large numbers of *Cyclops* at Cold Spring Harbor, L. I., where several fresh-water ponds afford excellent opportunities for the study of a variety of species. Though I have worked over some of this material with great care, I have never met with a single instance of a thirteen-jointed antenna.

In March of the present year, 1903, I again met with a number of *Cyclops* having thirteen-jointed antennæ. This material was collected in one of the large, shallow, fresh-water ponds at Jamaica, Long Island. The copepods were found in great numbers hidden beneath the fallen leaves along the edges of the pond. Again I noticed marked color-changes incident to the development and laying of ova. Some were red in the body and carried blue eggs in their paired sacs, while many were dark in color and carried about the partly developed reddish embryos.

Associated with these larger forms were smaller *Cyclops*, often without eggs, and emerald green to the naked eye, owing to the numbers of green protozoa that had attached themselves to the cuticle and almost concealed the host. The larger *Cyclops* with

the pink bodies and the blue eggs, or *vice versa*, were comparatively free from the one-celled forms. I believe this fact is important as pointing to the strong probability of a recent moult. Further study revealed the fact that the larger forms had invariably seventeen segments in the antennæ and that they agreed in all essential details with the species known as *C. parcus* (Herrick).

After formulating data gathered from the study of species-characters in many different individuals from the same locality, I was able to clearly distinguish three groups, in all of which, all the leading species-characteristics of *C. parcus* (Herrick) were combined with a varying number of segments in the antennæ, which, however, all belonged to the same type (Fig. 1).

Group I. comprised individuals with thirteen antennal segments.

Group II. comprised individuals with fourteen antennal segments.

Group III. comprised individuals with seventeen antennal ments.

Nearly all of the *Cyclops* referred to as covered by protozoa and hence appearing green, belong to Group II. or are intermediate between Groups I. and II., and are characterized by antennæ with fourteen segments either fully formed, or in process of forming. I have studied no less than ten individuals which show clearly that the fourteen-jointed antenna is derived from the thirteen-jointed one, by the division of the tenth segment — the fourth from the distal end of the antenna — which is divided almost equally into halves by a transverse partition.

It is *always* the tenth segment which is dividing at this stage, and in all cases recorded, when the two antennæ are not in the same stage of division, it is without exception the *left* that is in advance of the right, in which division can still be seen in progress, as in Fig. 1, *B*.

I know of no explanation of the retarded division in the right antenna, and it may be a mere coincidence that all of my observations agree on this point. One *Cyclops* in which the fourteen segments were perfectly formed in both antennæ, proved particularly interesting, for I believe it furnishes positive proof

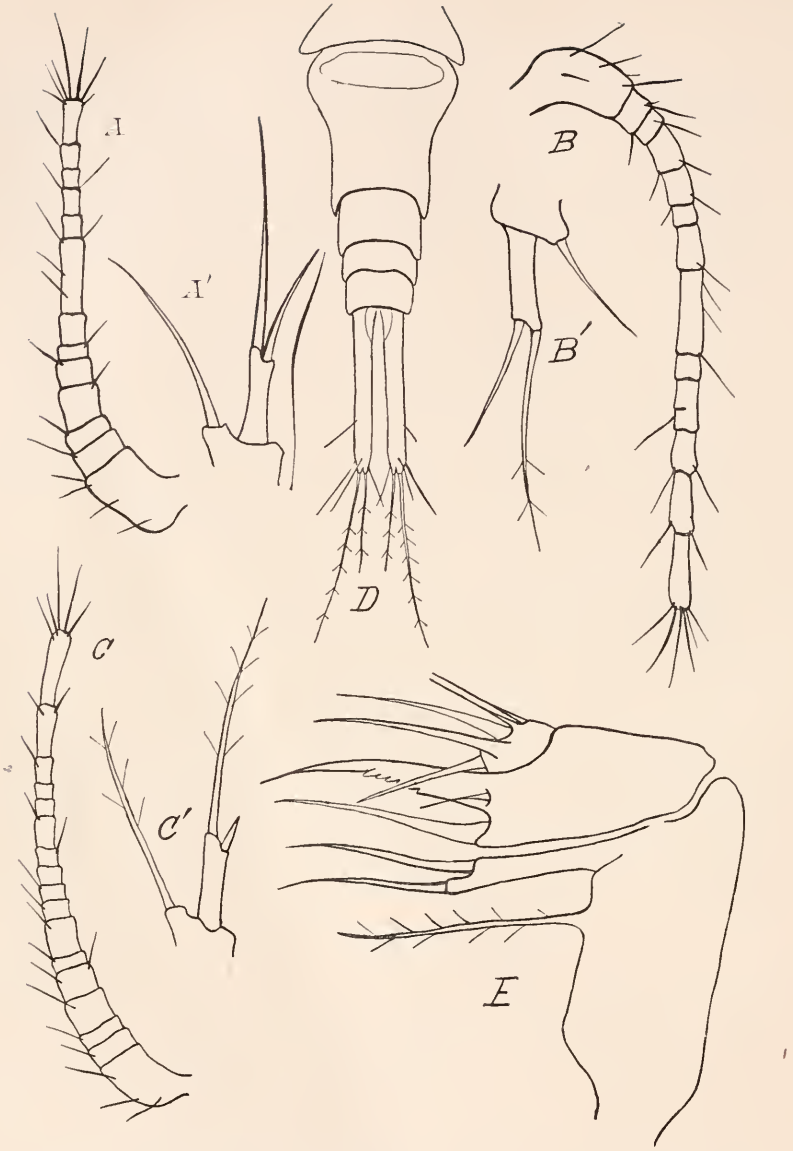

FIG. 1. Shows the antenna and fifth foot of a cyclops with thirteen-jointed antennæ, *A*, *A'*, Group I. The antenna and fifth foot of a cyclops with fourteen jointed antennæ, *B*, *B'*, Group II. The antenna and fifth foot of a cyclops with seventeen-jointed antennæ, *C*, *C'*, Group III. *D* shows the abdomen, the receptaculum seminis and the caudal stylets characteristic of all the forms with thirteen, fourteen or seventeen-jointed antennæ. *E* shows the large ramus of the maxilliped characteristic of the three forms. *B* also shows the tenth antennal segment in the act of dividing, thus giving rise to the fourteen-jointed antenna.

As compared with the length of the cephalothorax all the antennæ *A*, *B* and *C* shown in Fig. 1 are relatively long, extending to the first segment irrespective of the number of segments they contain.

that this apparently stable individual with the fourteen-jointed antennæ represents but a temporary condition in the development of a form with seventeen antennal segments. In the case referred to, the long eighth joint, that is characterized by three rather widely separated setæ, showed distinct, transverse lines across the segment at the level of each of the two lateral setæ. Half way up the remaining section, a slight indentation in the cuticle marked the position of the wall that completes the separation of this long segment into four small ones of almost equal size.

The breaking up of the eighth segment in the manner indicated by these markings gives to the seventeen-jointed antenna a short eighth segment with a single distal seta; a short ninth segment with a distal seta; a short tenth segment without any armature, and a short eleventh segment with one distal seta. These are precisely the conditions which prevail in the seventeen-jointed antennæ.

In his report on "The Entomostraca of Minnesota," Herrick describes a *Cyclops* strikingly like the one from Jamaica, Long Island, *with fourteen-jointed antennæ, three-jointed rami with the armature of the last joints like that given for C. parcus, and with a two-jointed fifth foot* "with the armature like *C. strenuus*, which also resembles *C. pulchellus*." The stylets are very long. These correlated peculiarities of structure are recognized as constituting a distinct species known as *Cyclops insignis* (Claus). Herrick mentions that "in a previous edition it was suggested that this is but an atavistic form of *C. pulchellus* — *C. strenuus*." If *C. strenuus* is to be regarded as practically the same form as *C. abyssorum*, as Schmeil suggests, the Long Island form can hardly be brought into relation with it, for the armature of the swimming feet, which is remarkably constant in forms of equal size, differs markedly in the two cases. Schmeil, however, seems to attach little importance to this fact.

That the Long Island form with the fourteen-jointed antennæ represents a transitional stage in the development of a seventeen-jointed form, there can be little doubt, though the determining of the species in the terms of an old and confused classification is by no means an easy matter. The length of the caudal stylets

is relatively greater in the *Cyclops* with the fourteen-jointed antenna than in the adult *C. parcus*, though in *C. parcus* the stylets are characteristically long. Another slight difference is seen in the presence of a hair in the form with the fourteen-jointed antennæ, in place of a small spine on the inner angle of the distal joint of the fifth foot of the seventeen-jointed form. Compare *A'*, *B'*, *C'*, Fig. 1. Moreover, the distal joint of the so-called *C. insignis* is strikingly long, longer than the corresponding joint in *C. parcus*. The difference between the two forms seems to be almost entirely one of proportion and size, the *insignis*-like form being slightly smaller than *C. parcus*, and often with fewer or no eggs.

In favor of the existence of a separate species for those forms with fourteen-jointed antennæ, and against the suggestion made by Herrick that *C. insignis* represents a transitional stage in development, Schmeil urged the occurrence of the *Cyclops* in large numbers, and its relatively large size, both of which *observations* I can confirm. I can not, however, agree with Schmeil's interpretation ; although the form is abundant and moderately large, it is often, though not always, without eggs either in the body or attached, when older forms associated with it are remarkably prolific. Moreover, if studied at the right stage, the form with fourteen segments in the antennæ gives frequent signs of being still in a period of growth characterized by morphological changes. The fact that the smaller form is densely covered by foreign growths indicates that it has not very recently moulted. In this connection it may not be irrelevant to allude to a few observations made on isolated copepods.

I separated a number of *Cyclops* in a small watch crystal. All were about the same size, some green to the naked eye, some dark, and others carrying eggs. A few days later my attention was drawn to a bright red *Cyclops* with a perfectly clean cuticle. It had seventeen segments in the antennæ, and from the absence of protozoa on its surface it must have moulted quite recently. I then looked about in the dish for cast-off skins and found one still well covered with protozoa and having fourteen-jointed antennæ.[1]

[1] Inasmuch as there were other individuals in the watch crystal, this is by no means *conclusive* proof that the seventeen-jointed form had shed the fourteen-jointed skin, but I could find no other explanation of its presence in the dish and I offer the fact for whatever it is worth.

I then set aside six *Cyclops* with fourteen-jointed antennæ, giving them clean hydrant water containing but little food and some fresh-water plants. At the time of their separation two had fourteen segments only in the left antenna, while the right antenna of each contained a dividing segment, the tenth from the base of the antenna, or the fourth from the distal end. Two weeks later the division of the segment was still incomplete, showing that in this case at least, the formation of partition walls is not very rapid. The bodies looked lighter and clearer than before, and I examined them again to see if any changes had taken place, but none had occurred.

In his explanatory notes accompanying Plate XXXIV.[1] which shows the species-characteristics of *C. parcus* (Herrick), Herrick shows "caudal stylets of an elongate form," in Fig. 3, with which my own drawings agree perfectly. It is quite possible that the elongated distal segment of the fifth foot may be a mere variation correlated with the elongation of the caudal stylets in Herrick's 'elongated form' of *C. parcus* which he suggests "is to be regarded as a post-imago."

A single characteristic which Herrick describes for *C. pulchellus*, but of which no mention is made in the characterization of *C. parcus*, to my knowledge, is the presence of serrations on the distal margins (ventral and lateral) of the last abdominal segment, while the remaining margins of the abdominal segments are free from such markings. All of the individuals of the three groups — *i. e.*, of the thirteen-, the fourteen- and the seventeen-jointed antennæ — agree with *C. pulchellus* in having these serrations, while Groups I. and II. also agree in having "two rather long setæ" which are not at all or only slightly plumose on the terminal segment of the fifth foot. But they all differ from *C. pulchellus* in not having the basal joint of the fifth foot longer than wide; the basal joint is unequivocally wider than it is long, and in this respect agrees with *C. parcus*.

Although the armature of the appendages is very constant in the Cyclopidæ, it is quite common to meet with similarly placed spines and setæ of different lengths. A notable instance of this

[1] "Copepoda, Cladocera and Ostracoda of Minnesota," Zoölogical Series, II., 1895, of the Geological and Natural History Survey of Minnesota.

occurs in the armature of the third joint of the large ramus of the maxillipeds of the fourteen-jointed and seventeen-jointed forms. The armature usually consists of three large hairs and two very small ones growing close together at the base of one of the large hairs (Fig 1, *E*). In the fourteen-jointed forms, these two small hairs are strikingly shorter than they are in the seventeen-jointed form. With this single exception, the maxillipeds are precisely alike in both groups.

I am aware that Herrick describes the armature of the terminal segment of the larger branch of the maxilliped of *C. parcus*, as consisting of four hairs. I have found an instance in which four large hairs of almost uniform size occur, but a more frequent condition in the Long Island *Cyclops* is seen in those instances which show three large hairs and two short ones, in place of the four hairs of Herrick (Fig. 1, *E*).

Among the many *Cyclops* I have studied, I have seen but one with eighteen segments in the antennæ. In this case the eighteenth segment is derived from the seventh segment, by transverse division, at the level of the seta. In both right and left antennæ the division is incomplete, extending but half way across the segment.

I have studied this *Cyclops* with great care, and in every detail of structure, it agrees perfectly with the forms associated with it in showing the chief species-characteristics of *C. parcus*.

I have repeatedly made written records of body-segments and appendages showing the complete armatures, and have made many outline drawings of those parts that are correlated in the determination of species, and I believe no room for doubt remains that the *Cyclops* with thirteen and with fourteen antennal segments, as well as the form with eighteen segments, are all to be referred to the type with seventeen segments in the antennæ. Those having thirteen and fourteen segments, known as *C. insignis*, though very abundant forms and though sexually mature, do not represent a group of sufficient permanency to warrant us in regarding them as representatives of a distinct species. They are rather to be considered as transitory stages which, though capable of producing young, have not as yet attained their maximum growth, or their highest degree of complexity.

The *Cyclops* with the eighteen-jointed antennæ agrees with Claus' description of *Cyclops elongatus*, so far as Herrick has quoted Claus. Nevertheless, its close agreement in all species-characteristics with *C. parcus*, with which it was found, and the very exceptional occurrence of so many antennal segments, make it highly probable that we are dealing here with a case of variation rather than with a species-character.

The *Cyclops* from Cold Spring Harbor, Long Island, were collected at the surface of a very shallow pond along a road-side near the laboratory of the Brooklyn Institute. The pond was choked with water-plants and a scum of duck-weed floated on the surface. From the extreme shallowness of the pond, any life there must have been exposed to rapidly changing conditions. The material collected in this pond was all taken from one locality within a radius of a few feet, where the copepods were in among the duck-weed.

I attempted some statistical studies in variation on these forms, but the work was soon interrupted by the comparatively small number of individuals belonging to the same species, or to species closely enough related to warrant any use of them in obtaining data. Most of the forms I have been wholly unable to identify, for while they agree with well known species in certain characteristics, they differ from them in others which are apparently no less important.

Certain combinations of characters occur so frequently, that, in the absence of transitional forms, one is often tempted to believe that in the bewildering array of forms before him, he is dealing with new variations, of which it is almost impossible to say whether they have a species value or not. Whether the forms met with illustrate pædogenesis, or whether the season was connected in any way with the morphological aspect of the copepods, I cannot say, not having been able to collect from this vicinity at any other season. But I have not seen any transitional stages in an individual such as would warrant the linking of it with any well known species.

One *Cyclops* frequently met with, combines the following characteristics: *Antennæ nine-jointed; rami of swimming feet two-jointed; rudimentary fifth foot one-jointed.*

Armature of the Swimming Feet.

First Foot.		Second Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus.*
3 outer spines.	1 outer seta.	3 outer spines.	1 outer seta.
1 apical spine.	1 apical spine.	1 apical spine.	1 apical spine.
1 apical seta.	1 apical seta.	1 apical seta.	1 apical seta.
4 inner setæ.	5 inner setæ.	4 inner setæ.	5 inner setæ.

Third Foot.		Fourth Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus.*
3 outer spines.	1 outer seta.	3 outer spines.	1 outer seta.
1 apical spine.	1 apical spine.	1 apical spine.	2 apical spines.
1 apical seta.	1 apical seta.	1 apical seta.	
4 inner setæ.	4 inner setæ.	4 inner setæ.	3 inner setæ.

The antenna and fifth foot of this form are seen in Fig. 2. The pravalence of the form alone is not sufficient reason for

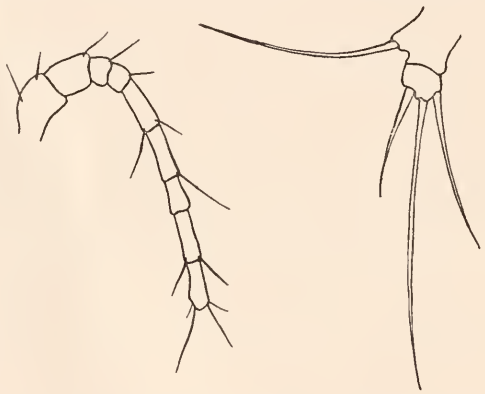

Fig. 2. Shows the antenna and the fifth foot of a cyclops with nine antennal segments. The fifth foot is two-jointed and resembles the fifth foot of the cyclops with the ten-jointed antennæ.

regarding it as a distinct species, and the probability is that we are here dealing with a transitional stage in the development of a species with a greater number of antennal segments, as seen in the case of the fourteen-jointed form, for no species in its mature condition is recognized as having nine antennal segments, while the fact that *the rami are two-jointed and the number of setæ on the last joint of the inner ramus is exceptionally large*, suggests that the rami may subsequently acquire a third joint. Moreover, the armature of the feet is strikingly like the armature of another *Cyclops* having ten antennal segments.

This second form which occurs frequently in the same locality,

combines the following characteristics: *Antennæ ten-jointed; rami of swimming feet two-jointed; rudimentary fifth foot two-jointed.*

ARMATURE OF THE SWIMMING FEET.

First Foot.		Second Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus.*
3 outer spines.	1 outer seta.	3 outer spines.	1 outer seta.
2 apical spines.	1 apical spine.	1 apical spine.	1 apical spine.
3 inner setæ.	1 apical seta.	1 apical seta.	1 apical seta.
	5 inner setæ.	4 inner setæ.	5 inner setæ.
Third Foot.		Fourth Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus.*
3 outer spines.	1 outer seta.	3 outer spines.	1 outer seta.
1 apical spine.	1 apical spine.	1 apical spine.	1 apical spine.
1 apical seta.	1 apical seta.	1 apical seta.	1 apical seta.
4 inner setæ.	4 inner setæ.	4 inner setæ.	3 inner setæ.

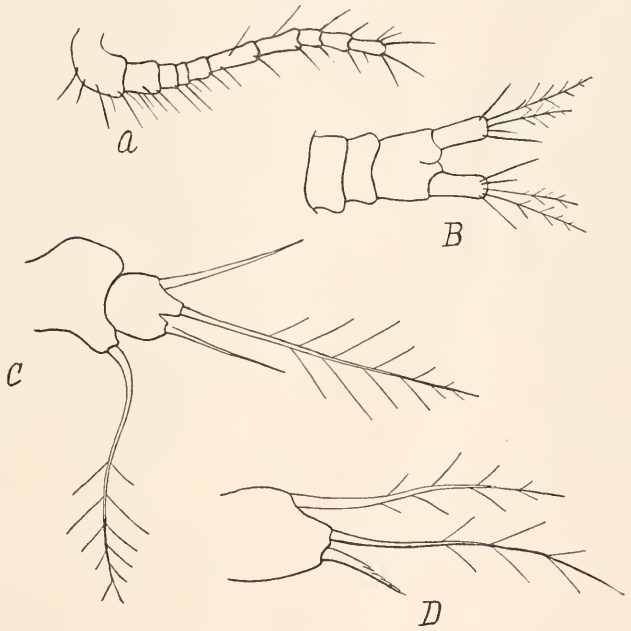

FIG. 3. The antennæ, the abdomen and caudal stylets and the two types of fifth foot correlated with the 10-jointed antennæ. *C* shows the fifth foot correlated also with the 9-jointed antennæ, while *D* shows the fifth foot correlated with the 11-jointed antennæ. *B* represents the type of abdomen and stylets correlated with 10 antennal segments irrespective of the form of the fifth foot.

Wherever these forms with the nine- and ten-jointed antennæ occur they show the same striking similarity in the armature of the swimming feet. *The nine-jointed forms are perfectly constant*

throughout the group, but *the ten-jointed forms vary considerably within the group*, occasionally combining three-jointed rami with a two-jointed fifth foot, and occasionally two-jointed rami with a one-jointed fifth foot.

According to Herrick's classification of the Cyclopidæ, there is but one species having ten-jointed antennæ, *i. e.*, *C. phaleratus*, which may combine either *ten- or eleven-, usually eleven-jointed, antennae with three-jointed rami in the swimming feet, and with a one-jointed fifth foot.* I have found this combination in a single case, and the antennæ contained each eleven segments. Herrick gives only the formula for the fourth foot of *C. phaleratus*, with which the above form also agrees. The entire armature of the terminal joints of the four swimming feet in the Cold Spring Harbor form is shown below.

First Foot.		Second Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus.*
3 outer spines.	1 outer seta.	3 outer spines.	1 outer seta.
1 apical spine.	1 apical spine.	1 apical spine.	1 apical spine.
1 apical seta.	1 apical seta.	1 apical seta.	1 apical seta.
3 inner setæ.	3 inner setæ.	4 inner setæ.	3 inner setæ.

Third Foot.		Fourth Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus*
3 outer spines.	1 outer seta.	2 outer spines.	1 outer seta.
1 apical spine.	1 apical spine.	1 apical spine.	2 apical spines.
1 apical seta.	1 apical spine.	1 apical seta.	
4 inner setæ.	3 inner setæ.	4 inner setæ.	2 inner setæ.

The length of the antenna in *C. phaleratus* as compared with the cephalothorax is short, whereas in the Cold Spring Harbor form the antennæ are relatively long, extending nearly to the second thoracic segment. Moreover, in a single instance the long second joint of the antenna showed a light, transverse band near its proximal margin, suggesting the characteristically short second segment of the eleven-jointed antenna.

The chief characteristics of the cyclops with the eleven-jointed antennæ are *three-jointed rami in the swimming feet combined with a two-jointed fifth foot* (Fig. 4).

Herrick recognizes three species having eleven antennal segments; one of these is a European form of marked peculiarity; a second is *C. diaphranus*, whose species-characteristics are *eleven-jointed antennæ, two-jointed rami in the swimming feet, and a one-jointed fifth foot, with a long seta and one short spine.*

I have not found a single *Cyclops* combining these characters. The eleven-jointed antennæ are, with one exception, so far as my studies show, always correlated with *three*-jointed rami in the

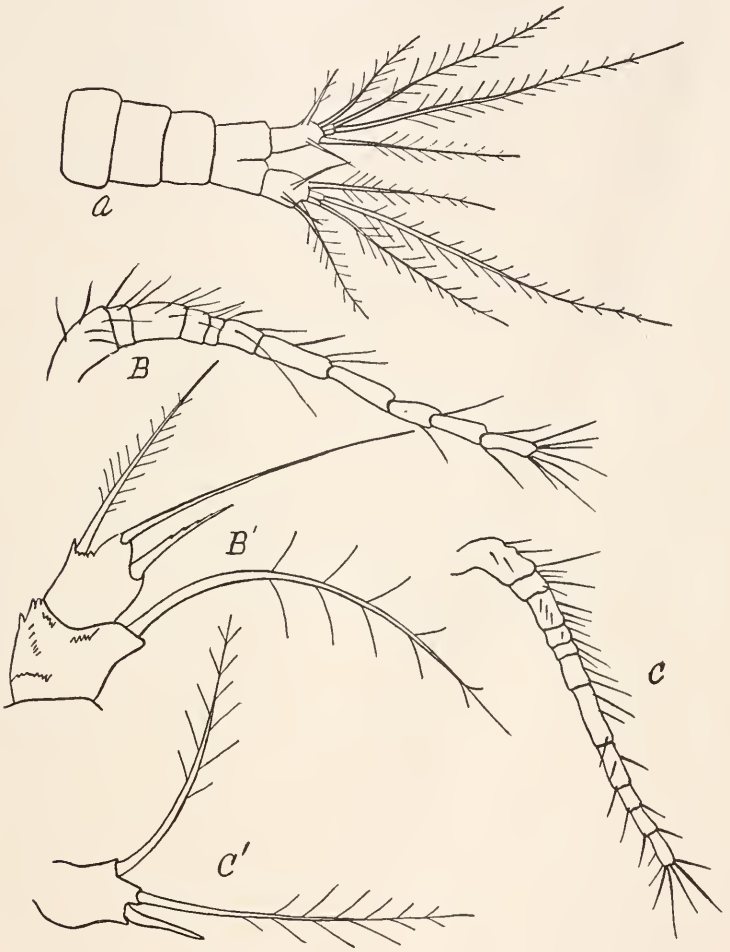

FIG. 4. Represents an eleven-jointed antenna, *B*, correlated with a two-jointed fifth foot *B'* and short caudal stylets with very long, plumose setæ, *A*. *C* and *C'* represent an eleven-jointed antenna and a correlated one-jointed fifth foot with the same abdomen and stylets as are seen in the form with the eleven-jointed antennæ and the two-jointed fifth foot.

swimming feet, and the armature of these forms is precisely like that of *C. phaleratus*, whether the fifth foot be one-jointed or two-jointed. The third species having eleven-jointed antennæ which

Herrick recognizes, also combines a one-jointed fifth foot with two-jointed rami. It is known as *C. affinis* and is like *C. phaleratus*, "which it closely resembles."

A fourth and a last type to which I shall refer, is seen in a not infrequently occurring form *which combines twelve-jointed antennæ with three-jointed rami in the swimming feet and a two-jointed fifth foot* (Fig. 5).

Herrick recognizes three species as having these characteristics, namely: *C. capillatus* and *C. crassicaudis*, both European

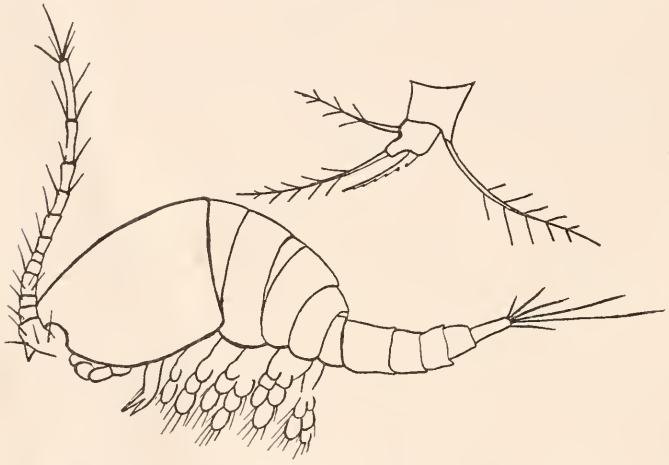

FIG. 5. Shows a twelve-jointed antenna which is relatively very long as compared with the cephalothorax, notwithstanding the relatively small number of antennal segments present.

forms, and *C. varicans*, an American form. The two former are described as Scandinavian forms only. Of the third species *C. varicans*, Herrick says that it is "the American species most nearly resembling the European form with twelve antennal segments and a two-jointed fifth foot." "Unhappily," Herrick also remarks, "this species was taken but once." On Plate XXX.[1] Herrick figures the first foot of *C. varicans*, which he pictures as having two-jointed rami in the swimming feet. Herrick explains that the last joint is homologous to two fused segments, and that the separation might take place "at the next moult." The form I have studied shows the armature when the rami have reached

[1] "Copepoda, Cladocera and Ostracoda of Minnesota."

the three-jointed condition, and the reduction in the number of spines and setæ in the armature of the fourth foot might seem to bear out Herrick's suggestion.

C. Varicans. Fourth Foot.		Cold Spring Harbor Cyclops. Fourth Foot.	
Outer Ramus.	*Inner Ramus.*	*Outer Ramus.*	*Inner Ramus.*
3 outer spines.	1 outer seta.	2 outer spines.	1 outer seta.
1 apical spine.	1 apical spine.	1 apical spine.	2 apical spines.
1 apical seta.	1 apical seta.	1 apical seta.	
4 inner setæ.	4 inner setæ.	4 inner setæ.	2 inner setæ.

The armature of the Long Island form suggests *C. phalcratus*, though in the first foot it is not identical.

I have found three of these forms among a relatively small number of individuals and they agree very closely with one another, the only difference being in a slight variation in the armature of the swimming feet, a spine occasionally appearing in place of a seta.

Supposing that these individuals represent *C. varicans*, the Cold Spring Harbor form is very evidently in a later stage of development than the individual figured by Herrick. Any appeal to relative ages as an explanation of differences, requires the supposition that some of the segments of the feet have an adult armature while other segments have not. But there is no reason for supposing that the number of spines and setæ in the fourth foot is incident to the breaking up of the rami into three segments instead of two, for the armature of the first foot is not reduced by the presence of the additional joint in the rami.

Summary.

The Long Island *Cyclops* (*C. insignis?*), having fourteen-jointed antennæ, three-jointed rami in the swimming feet, with two-jointed fifth feet and elongate caudal stylets, is a transitional stage in the development of a seventeen-jointed form *C. parcus* (Herrick?). The eighteen-jointed antenna is derived from the seventeen-jointed form by division of the seventh segment.

Out of fifteen individuals taken at random, none of whose antennal segments exceed twelve, five precisely similar individuals constitute a group having *nine antennal segments*, *two-jointed rami* and *two-jointed fifth feet*.

Four individuals constitute a second group having typically *ten antennal segments*, *two-jointed rami*, and *two-jointed fifth feet.* Two of these individuals show marked variation, one in having *three-jointed rami* in the swimming feet, the other in having a *one-jointed fifth foot.*

Four individuals constitute a third group, characterized by *eleven-jointed antennæ*, *three-jointed rami*, and *two-jointed fifth feet.* One member of this group has a *one-jointed fifth foot*, and *this is the only individual out of the thirteen that can be given any place among species*, *i. e.*, *C. phaleratus*, as combining well recognized species-characters.

Three individuals constituting a fourth group combine the following characteristics: *twelve-jointed antennæ*, *three-jointed rami*, and *two-jointed fifth feet.* These forms suggest *C. varicans*, with which they have much in common, but from which they differ considerably in detail.

Some facts point to the probability that the Cold Spring Harbor forms with the ten-jointed antennæ are morphologically undeveloped. Especially does the variation within the group consisting of but few individuals point to the instability of these forms.

What the true nature of these correlated peculiarities in *Cyclops* may be, can only be determined by following the life history of each individual. The relatively large size of these forms, and the frequency with which they occur, as well as the constancy of the correlated characteristics, suggest on first acquaintance with the Cyclopidæ, that they represent distinct species, but a fuller acquaintance warns us to look further for an explanation of these most perplexing variations which are doubtless largely due to the acquiring of sexual maturity while the morphological changes in the body are still incomplete, and to the varying external conditions to which they are subjected.

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